

Pathogenicity and metalaxyl sensitivity of *Phytophthora infestans* isolates obtained from garden huckleberry, potato and tomato in Cameroon[☆]

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Abstract

Late blight is a significant disease of solanaceous crops worldwide. Knowledge of pathogenicity of isolates and metalaxyl sensitivity is important for effective management of late blight. Solanaceous crops were surveyed in the highlands of west and northwest provinces of Cameroon during 2001 and 2002. A total of 233 isolates of *Phytophthora infestans* were collected, of which 53 were from huckleberry, 104 from potato, and 76 were from tomato. The pathogenicity of the isolates were conducted on detached leaves of huckleberry, potato and tomato and, metalaxyl sensitivity was assayed on leaf disks at 18 °C. The results of pathogenicity tests showed that the potato, tomato and huckleberry isolates infected their primary hosts of origin as well as the other two plant hosts. The isolates of *P. infestans* from huckleberry were more aggressive on potato and tomato than on huckleberry. The potato isolates were most pathogenic on potato and least pathogenic on huckleberry. The tomato isolates were equally aggressive on potato and tomato, and significantly less pathogenic on huckleberry. Sensitivity of *P. infestans* isolates to metalaxyl varied with the geographic location where the isolates were collected and source of isolation (primary hosts). Among the 233 isolates tested for metalaxyl sensitivity, 49% were metalaxyl resistant (MR) in 2001 and 51% in 2002. The least percentage of isolates (34%) obtained huckleberry, were MR. The aggressiveness of the isolates were increased with their corresponding resistance to metalaxyl. The cross-infectivity of the isolates and their increased metalaxyl resistance suggests that integrated management options are essential for effective disease control.

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Keywords: Metalaxyl sensitivity; *P. infestans*; Huckleberry; Potato; Tomato; Infection frequency; Cameroon

1. Introduction

Late blight, caused by *Phytophthora infestans* (Mont.) de Bary is an important disease on potato (*Solanum tuberosum* L.) and tomato (*Lycopersicon esculentum* Mill.) worldwide. It is the most important pathogen of garden huckleberry (*Solanum scabrum* Mill.), potatoes

and tomatoes in the tropical highlands of Cameroon. In this scenario, yield losses have been reported at 46% in huckleberry (Fontem et al., 2003), 71% in potato (Fontem and Aighewi, 1993; Fontem et al., 2001) and 100% losses in tomato fruits (Fontem, 2003).

In Cameroon, late blight is controlled through intensive use of fungicide. Metalaxyl is sold as a premixed formulation with copper oxide (Ridomil Plus) or mancozeb (Ridomil MZ) for late blight management in potato and tomato (Fontem et al., 2001). Although, resistance of *P. infestans* to metalaxyl has been reported in many countries (Coffey and Young, 1984; Cohen and Coffey, 1986; Davidse et al., 1981; Deahl et al., 1993;

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McLeod et al., 2001; Gisi and Cohen, 1996; Mukalazi et al., 2001), limited information is available on the sensitivity of *P. infestans* isolates to metalaxyl in Cameroon. Recent studies reveal that the occurrence of metalaxyl resistance in *P. infestans* populations is associated with severe late blight epidemics, genetic diversity and pathogen resurgence (Davidse et al., 1981; Goodwin et al., 1992; Kadish et al., 1990).

The pathogenicity of isolates of *P. infestans* from various host species have not been adequately documented in Cameroon. Knowledge of the pathogenicity of the isolates from various host plants, their sensitivity to metalaxyl is very important for the development of late blight management strategies in the tropical highlands of Cameroon. The objectives of this study were (i) to assess the pathogenicity and cross infectivity of *P. infestans* isolates from huckleberry, potato and tomato; (ii) to evaluate the sensitivity of the isolates to metalaxyl, and (iii) to assess the aggressiveness of metalaxyl sensitive or resistant strains of *P. infestans*.

2. Materials and methods

2.1. Survey and collection of isolates

A systematic survey was conducted in the major potato growing regions of Cameroon mainly in the western and north-western provinces during 2000 and 2001 cropping seasons. In each region or division, potato fields were sampled at a distance of 8–15 km apart along main road axes. The host variety on which late blight was detected, plot size, fungicides used, late blight incidence and severity were also recorded. At each collection site, the longitude latitude and altitude were recorded using a GPS unit (GPSMap 76S, Garmin). A total of 88 fields were sampled during 2001 and 116 fields during 2002.

At each site, leaflets containing single lesions of late blight disease were randomly picked in the field and placed into ice-box coolers. Fresh huckleberry, potato and tomato leaves showing late blight symptoms were collected from Bamboutos and Menoua divisions in the west province and Bui and Mezam divisions of the North-West provinces of Cameroon (Fig. 1) during August–November 2001 and June–September 2002. Mezam is the highest huckleberry-producing region in the country, while Bui and Menoua and Mezam and Menoua are the highest potato- and tomato-producing regions, respectively.

2.2. Preparation of inoculum

Diseased samples were brought to the laboratory and isolations were made on V-8 agar. *P. infestans* cultures were obtained using standard isolation techniques.

Isolates of *P. infestans* were transferred onto V8 medium amended with antibiotics in 90 mm diameter petri dishes for about 14 days at 18 °C in darkness for sporangia production. Inocula were harvested from 10 to 14 day old cultures by adding 10 ml sterile distilled water and a drop of Tween 20 to each plate and scraping the surface lightly with the edge of a glass rod to dislodge sporangia. Sporangial suspensions were filtered through a double layer of cheesecloth to remove mycelial fragments and were diluted to 20,000 sporangia/ml with the aid of a haemocytometer. The sporangia were chilled at 4 °C for 2 h to induce zoospore liberation.

2.3. Infection frequency of *P. infestans* isolates from huckleberry, potato and tomato

Potato tubers (cv. Hydra) and tomato seeds (cv. Roma) were obtained from commercial suppliers, while garden huckleberry seeds (var. SS15) were obtained from the indigenous vegetable seed bank of the University of Dschang. All seeds were grown in 10 cm diameter plastic pots in a screen house (10–20 plants per species). The soil was amended with 20-10-10 NPK fertilizer at 0.5 kg/m² and the pots were watered as needed. Pathogenicity tests were performed on detached leaves of huckleberry, and leaflets of potato and tomato. The healthy leaves were detached from the middle canopy layer of 4–6-week old plants which were present in the screen house. The leaves were washed with running tap water for about 1 min and blotted slightly on paper towels to remove excess moisture. The base of each detached leaflet was covered with a piece of moist cotton to reduce leaf desiccation. The leaves were then placed down (abaxial surface up) in 90 mm diameter petri dishes containing moistened filter paper. A single leaf or leaflet was placed in each petri dish.

To determine infection frequency of *P. infestans*, isolates from huckleberry, potato and tomato were used to inoculate each of the above host combinations. The experiment was established as a 3 × 3 factorial arranged in a completely randomised design with 4 replications. Twenty isolates per/host were regarded as sub-samples and their pathogenicity scores averaged. Each isolate was inoculated on the three test hosts separately. All 60 isolates were tested in one experiment, and another 60 in the second experiment. A total of 120 isolates were selected for each year of the experiment. Detached leaves were inoculated separately with isolates of *P. infestans* and incubated at 18 °C for 7 days. The inoculations were done in a single experiment. Infection frequency was determined as number of leaflets per test variety infected/total number of leaflets multiplied by 100. The cross-infectivity of the isolates were therefore, determined by assessing the percentage of huckleberry, potato and tomato leaves infected with *P. infestans* isolates from huckleberry, potato and tomato.

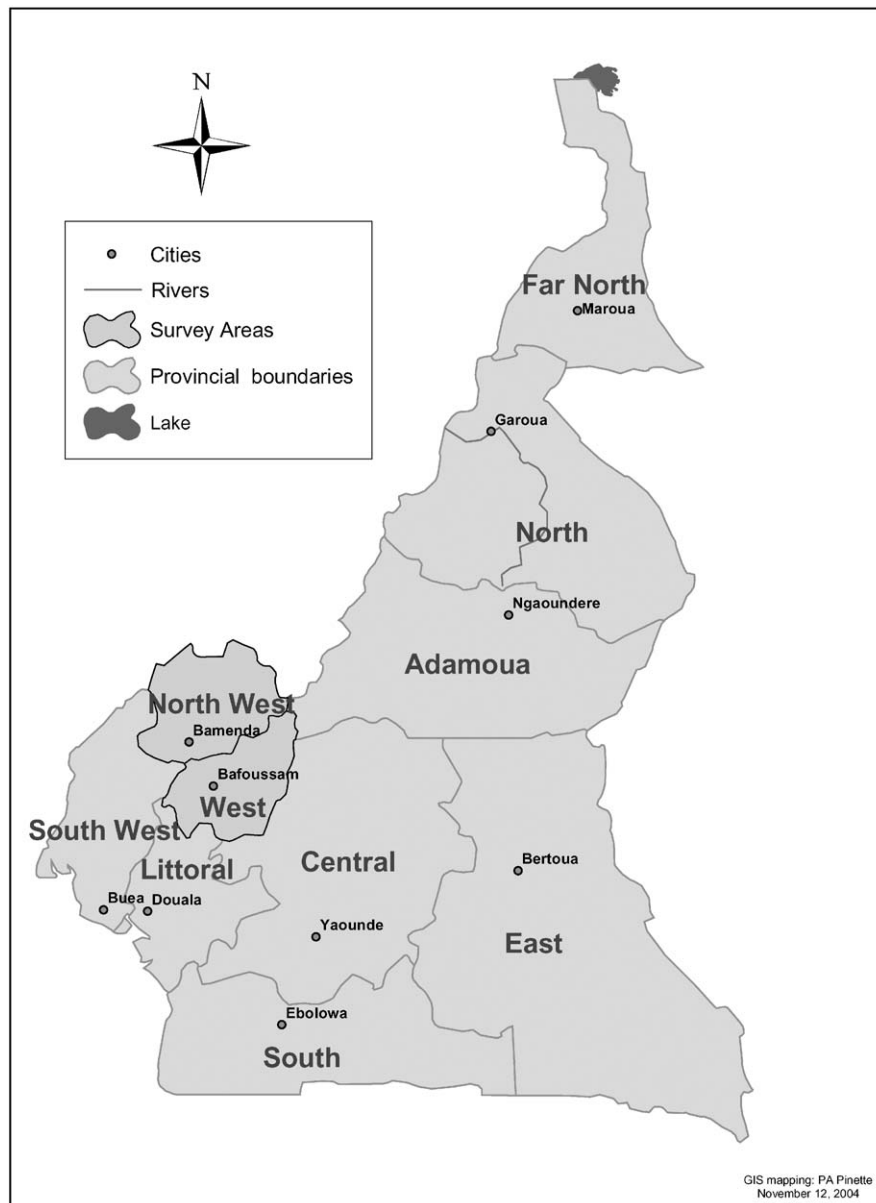


Fig. 1. Map of Cameroon showing administrative provinces and the area surveyed for potato late blight in the North-west and West Provinces.

2.4. Late blight severity of *P. infestans* isolates on huckleberry, potato and tomato plants

The experimental design consisted of a $3 \times 3 \times 4$ factorial (inoculum type from 3 hosts \times 3 test species inoculated \times 4 regions) arranged in a completely randomised design with 4 replications. A total of 120 isolates (60 isolates each in 2000 and 2001 respectively of which 5 isolates were selected from each host in four divisions). Detached leaflets from each of the host species were inoculated with isolates of *P. infestans* obtained from garden huckleberry, potato or tomato following the method of Mukalazi et al., 2001. A single drop (50 μ l) of the zoospore suspension of each isolate was applied to the midrib of the leaflets placed in the petri dishes. All

tests were conducted in a single experiment. Control treatments contained a drop of solution (distilled water + Tween 20). The inoculated leaves and leaflets were placed in the incubator in the lab at (18 °C, 12 h photoperiod, 95 \pm 2% RH) for 7 days. Pathogenicity of the isolates were determined by assessing late blight severity using a visual assessment scale from the modified Horsfall–Barratt rating scale (Berger, 1980).

2.5. Disease component (lesion size) of *P. infestans* isolates from various host species

Disease component of isolates of *P. infestans* were determined on detached leaflets of 4-week-old seedlings of huckleberry, potato and tomato plants. Inoculum

type consisted of isolates from huckleberry, potato and tomato plants. The experimental design and inoculations conditions were conducted as described in the previous experiment. Twenty isolates per host were regarded as sub-samples (inoculum type) and their pathogenicity scores were averaged. Aggressiveness was determined by assessing the lesion length and width (mm) of diseased leaves from which lesion sizes were calculated.

2.6. Metalaxyl sensitivity tests of *P. infestans* isolates from various plant hosts

The reaction of the fungal isolates to metalaxyl was tested using the leaf disks method (Deahl et al., 1993). Potato leaf disks (15 mm diameter) were cut with a sterilised cork borer from fully expanded leaves of 4–6 week old garden huckleberry (var. SS 15), potato (cv. Hydra) and tomato (cv. Roma) plants. The leaf disks were placed abaxial side up in 9-cm diameter petri dishes on moistened filter paper. The experimental design consisted of a 3×3 factorial experiment (3 metalaxyl concentrations \times 3 inoculum types—from huckleberry, potato and tomato), arranged in a CRD with 4 replications. The filter paper on which the leaf disks were placed were saturated with solutions of 0 (control), 10 and 100 $\mu\text{g/ml}$ of metalaxyl dissolved in 1% acetone. Each disk was inoculated with a 50- μl drop of sporangial suspensions of *P. infestans* from different inoculum type (isolated from huckleberry, potato or tomato). Each petri dish consisted of 5 leaf disks samples. Inoculated disks were incubated in the laboratory at 18 °C for 8 days, with a 12 h photoperiod and examined under a dissecting microscope for fungal infection (disease symptoms). Isolates unable to sporulate on leaf disks treated with various doses of metalaxyl were rated as sensitive. Isolates that had sporulation on greater than 50% of leaf disks placed in the 10 and 100 $\mu\text{g/ml}$ of metalaxyl were rated as resistant. Isolates that had less than 50% sporulation on disks placed in 10 $\mu\text{g/ml}$ relative to the control were rated as intermediate.

2.7. Data analysis

Data on disease severity of late blight isolates and fungal aggressiveness (lesion size) were analysed using Proc GLM of the statistical analysis system. To determine cross-infectivity of *P. infestans* infection of huckleberry, potato and tomato, data were analysed by Proc Means of the Statistical Analysis System (SAS, 1995). Data was transformed using the arcsine $[(x+1)/100]$ transformation for per cent late blight severity and metalaxyl sensitivity and the square root $(x+0.5)$ transformation for lesion size to reduce heterogeneity of variance prior to analysis. The data for late blight

severity (%) and lesion size (mm) were subjected to an analysis of variance (ANOVA). The control treatments were not included in the analysis since no disease developed on the leaves inoculated with distilled water. Chi square tests were computed and used in the comparison of the frequency distribution of metalaxyl sensitivity of isolates based on sampling regions in both years and host of origin. The relationships of the geographic origin of the isolates, their metalaxyl sensitivity and aggressiveness were also examined.

3. Results

3.1. Survey of *P. infestans* isolates in Cameroon

A total of 245 isolates from *P. infestans* were collected from huckleberry, potato and tomato fields during 2001 and 2002 in the western highlands of Cameroon (Fig. 1). The altitude of the sites at which *P. infestans* was collected were from 960 to 2220 meters above sea level (masl). Isolates from huckleberry and tomato were obtained from all the five divisions, while those from potato were obtained from Bamboutos, Bui, Menoua and Mezam divisions. The field sizes from which *P. infestans* were detected were in the range of 200–12 000 m^2 . The fungicides applied for late blight control in the various regions in both years were Dithane M-5 (mancozeb, Ridomil Plus (12% metalaxyl + 60% cuprous oxide) or Dacobre (25% chlorothalonil + 25% copper oxychloride). We recorded fungicide application rates of 3 to 5 times higher than recommended rates.

3.2. Infection frequency of huckleberry, potato and tomato by isolates of *P. infestans*

In both years, no late blight symptoms developed on detached leaves of huckleberry or leaflets of potato and tomato inoculated with distilled water (control). The infection frequency varied with the inoculum type or the primary hosts from which *P. infestans* were isolated. When the inoculum was from huckleberry, infection frequencies on the three hosts were similar. The average infection frequency were 53%, 64% and 68% on huckleberry, potato and tomato, respectively. *P. infestans* isolates from potato (potato inoculum type) caused the greatest amount of disease on all hosts and ranged from 88% to 100%. The mean infection frequency were 88%, 90% and 97% on huckleberry, potato and tomato, respectively. When the inoculum type (isolate) was from tomato, the average infection levels were 74% on huckleberry, 86% on potato and 90% on tomato. The *P. infestans* isolates from the three host-species (huckleberry, potato, tomato) were observed to readily cross-infect the three hosts species and develop high levels of late blight severity.

3.3. Disease severity and lesion size of late blight isolates on huckleberry, potato and tomato plants

There was no significant effect of plant hosts on late blight severity. A significant inoculum type \times host interactions ($P < 0.05$) was detected (Table 1). The severity of potato late blight was lower in 2001 compared to 2002 cropping season. In 2001, the lowest level of late blight severity was recorded when isolates from the three host species (inoculum types) were inoculated on huckleberry. The average disease incidence on huckleberry was in the range of 13–15% in 2001 and from 8% to 23% in 2002. Higher disease levels were detected on tomato and potato plants. When detached leaves of tomato were inoculated with *P. infestans* inocula from huckleberry, potato and tomato, average disease levels were in the range of 11–43% and 17–50% in 2001 and 2002, respectively. On detached potato leaves, mean late blight incidences were from 11% to 41% and 22% to 47% in 2001 and 2002, respectively. The sources of inoculum (inoculum type) did not have a significant effect on lesion size (Table 1). However, inoculum type by host interactions were significant ($P < 0.05$). When the inoculum source was from potato, lesion size were generally greater on potato than on tomato or huckleberry leaves. The inoculum sources from tomato hosts were equally aggressive on tomato and potato leaves.

3.4. Sensitivity of *P. infestans* isolates to metalaxyl fungicide

The results of metalaxyl sensitivity tests revealed a low frequency (11–34%) of *P. infestans* isolates that are

metalaxyl sensitive in Cameroon. The sensitivity of the isolates varied with the geographic origin and their primary hosts of isolation (Figs. 2 and 3). During the 2001 cropping season, a high-frequency of metalaxyl resistance (MR) was recorded in the northwest provincial divisions of Bui (67%) and Mezam (63%), compared to the west provincial divisions of Menoua (47%) and Bamboutos (27%) (Fig. 2). In 2002, high frequencies of MR were observed in Bui (58%), Mezam (52%) and Menoua (56%) divisions and the least MR isolates were detected in Bamboutos (38%). Chi square tests for the frequency distribution of metalaxyl sensitivity of isolates based on sampling sites in both years showed that it was significantly influenced by geographic origins of the isolates ($X^2 = 69.12$, $P < 0.001$ in 2001 and $X^2 = 27.14$, $P < 0.007$ in 2002). Overall, 49% of the 102 *P. infestans* isolates assayed for metalaxyl sensitivity in 2001 were recorded as MR, while 51% of 131 isolates evaluated were recorded as

Table 1

Analysis of variance on late blight severity (%) and lesion size on huckleberry, potato and tomato leaves at 7 days after inoculation with *Phytophthora infestans* isolates from different host species obtained from various regions of Cameroon

Source of variation	Df	F-value	$P > F$
<i>Late blight severity (%)</i>			
Reps	4	2.8395	0.0976
Inoculum type (IT) ^a	2	1.6042	0.2595
Reps \times inoculum type	12	5.6896	0.3445
Host (H) ^b	2	70.3685	0.0038**
IT \times Host	4	7.4933	0.0532*
<i>Lesion size (mm)</i>			
Reps	4	3.2851	0.0715
Inoculum type (IT) ^a	2	1.8051	0.2254
Reps \times inoculum type	12	7.8896	0.2945
Host (H) ^b	2	75.4114	0.0468*
IT \times Host	4	2.4909	0.0325*

*Significant at $P < 0.05$, and **significant at $P < 0.01$.

^aRefers to *P. infestans* inoculum obtained from potato, tomato and huckleberry.

^bPotato, tomato and huckleberry plants inoculated with late blight isolates obtained from three sources.

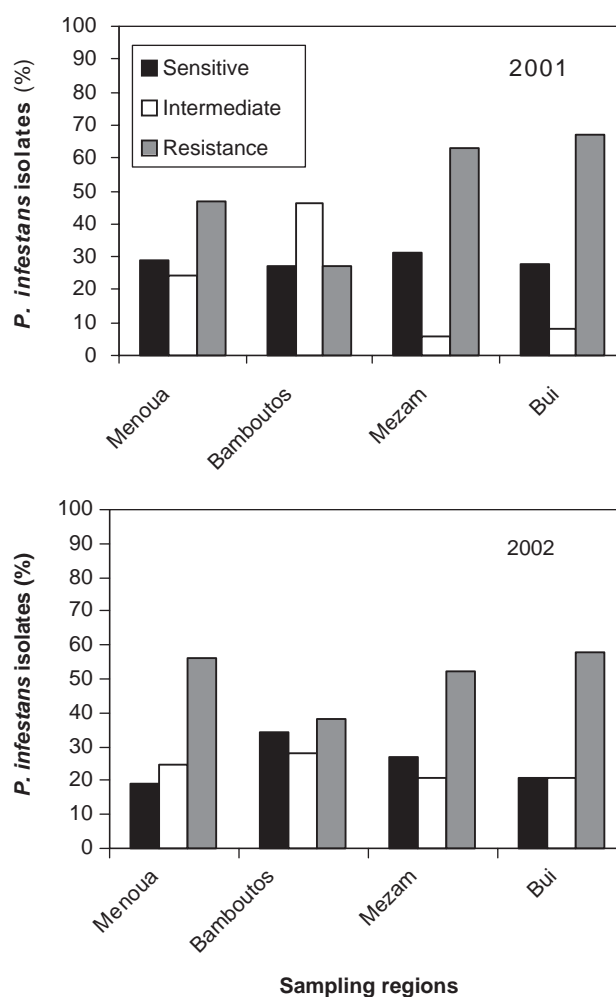


Fig. 2. Metalaxyl sensitivity of *P. infestans* isolates obtained from different geographic regions or divisions of Cameroon. The average altitude for Menoua, Bamboutos, Mezam and Bui are 1500, 1800, 2200 and 2400 m above sea level, respectively.

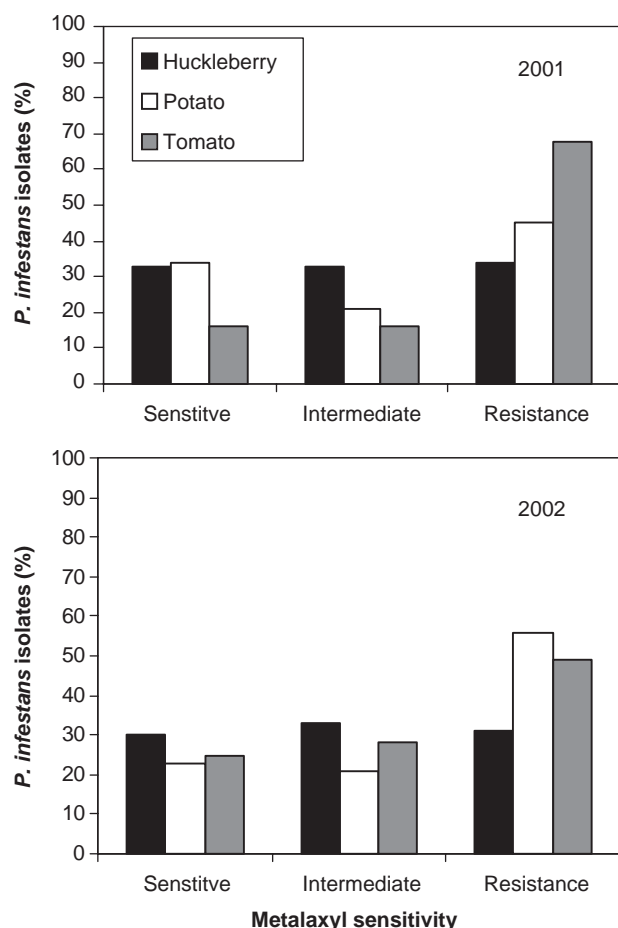


Fig. 3. Metalaxyl sensitivity (%) of *P. infestans* isolates obtained from huckleberry, potato and tomato. The total number of isolates tested on the host species were 24, 47 and 31 during 2001 and 29, 57 and 45 in 2002, respectively.

MR in 2002. In both years, the highest frequency of metalaxyl-resistant (MR) isolates were recorded on tomato (68%) in 2001 and (58%) in 2002, followed by potato (45%) in 2001 and (56%) in 2002 and least on huckleberry (Fig. 3). Chi square tests showed that the frequency distribution of metalaxyl sensitivity in both years was significantly affected by host of origin of the isolates ($X^2 = 26.23$, $P < 0.001$ in 2001 and $X^2 = 16.69$, $P < 0.022$ in 2002).

3.5. Relationship between metalaxyl sensitivity, aggressiveness of *P. infestans* isolates and their geographic origin

The relationship between metalaxyl sensitivity and aggressiveness of *P. infestans* isolates was compared for six randomly selected metalaxyl sensitive (MS), intermediate or moderate metalaxyl reaction (MI) and metalaxyl resistance (MR) isolates. In both years the sensitivity of the isolates varied with the host plants

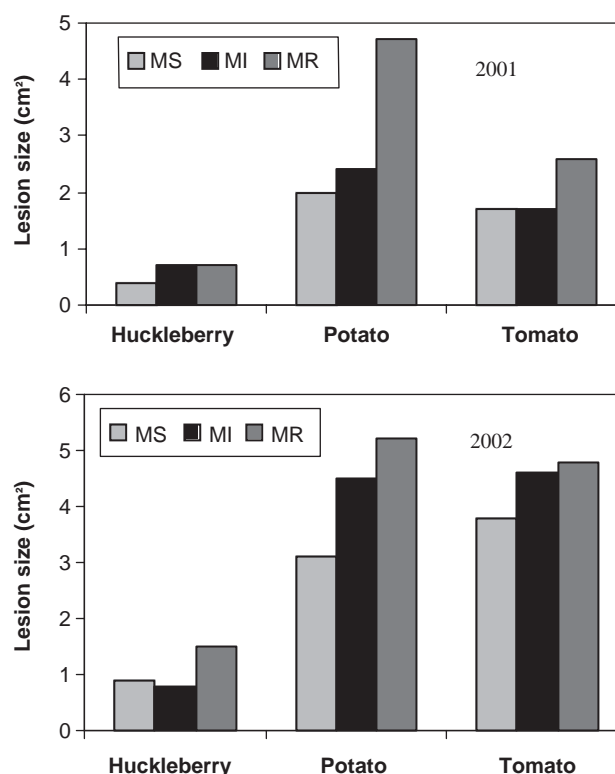


Fig. 4. Mean lesion size (cm) on potato, tomato and huckleberry incited by *P. infestans* isolates of various metalaxyl sensitivity during 2001 and 2002.

infected or diseased (Fig. 4). Lesion sizes varied with the degree of metalaxyl sensitivity in both years and metalaxyl-resistant isolates produced slightly greater lesion sizes on potato and tomato leaflets.

4. Discussion

The isolation of late blight from the three hosts suggest that the disease is perpetuated on potato, tomato and huckleberry hosts. Occurrence of late blight was detected in the western and north-western provinces of Cameroon. This is the major potato production zones in Cameroon and environmental conditions such as temperature, relative humidity and rainfall are often very conducive for disease development. Late blight was detected and isolated from huckleberry, potato and tomato hosts. In previous investigations, late blight had been reported as the most important production constraints on potato and tomato in Cameroon (Fontem and Aighewi, 1993; Fontem et al., 2001, 2003). In our study, we observed that solanaceous hosts consisting of huckleberry or tomato were frequently cropped with potato. This intercropping pattern may increase the risk of late blight infections. The presence of *P. infestans* isolates infecting huckleberry, potato and tomato indicates that similar blight management

strategies are necessary for the three crops. The use of other intercrops or cropping pattern as late blight management strategy should be examined.

Isolates of *P. infestans* from huckleberry, potato and tomato were pathogenic and readily infected the three hosts. This suggests that inoculum from the three host species is capable of initiating late blight epidemics. Our results showed that consistently lower disease levels were observed when the host species inoculated was huckleberry and that no significant effects of inoculum type on late blight severity or lesion size were recorded. This implies that inoculum source or type is not a significant factor in initiating late blight disease, but that potato and tomato are more suitable hosts compared to huckleberry, since disease levels were higher when host-species infected were either potato or tomato. In this study, the pathogen isolates from tomato, potato and huckleberry were capable in initiating disease and cross-infectivity occurred. Similarly, isolates obtained from different geographical regions, altitudes and temperature regimes were pathogenic. This suggests that host-adaptation of potato, tomato or huckleberry isolates is not a significant factor in Cameroon.

Our research results differ from other studies in that we did not detect any host specificity among tomato, potato and huckleberry isolates from Cameroon. In contrast, other researchers have shown variable results on host-specificity and pathogenicity of *P. infestans* isolates from tomato and potato. Research studies conducted with *P. infestans* isolates from Uganda (Vega-Sanchez et al., 2000); or Ecuador (Oyarzun et al., 1998) showed that populations of *P. infestans* attacking potato and tomato are host specific. Legard et al. (1995) identified tomato aggressive and non-aggressive *P. infestans* isolates based on their infection of potato and tomato hosts. Recent studies conducted with isolates from Uganda and Kenya (Mukalazi et al., 2001; Olanya et al., 2001a,b) showed that isolates from tomato and potato were equally aggressive. Therefore, we did not detect any host specificity among tomato, potato and huckleberry isolates from Cameroon.

The higher late blight levels recorded on potato compared to tomato and huckleberry as determined by the infection frequency and other disease parameters suggest that *P. infestans* isolates can cause more disease on potato than tomato compared to huckleberry. The significance of the interactions of inoculum type by host for late blight severity and lesion size parameters implies that inoculum types or sources resulted in various disease levels in the different hosts. Therefore, potato is a more suitable host compared to tomato or huckleberry. Huckleberry is an indigenous vegetable crop that has been cultivated for many years in Cameroon (Schippers, 2000; Stevels, 1990), however, the occurrence of late blight on huckleberry has just been reported recently (Fontem et al., 2003). It is possible

that the host adaptation of late blight isolates on huckleberry is of recent occurrence.

Significant inoculum type by host interactions were observed for lesion size in lab studies. Consequently variations in lesion size were observed among hosts from various geographic regions. Isolates of *P. infestans* from the north-western province (Bui and Mezam divisions) generally produced larger lesions on the three hosts. These regions have an average altitude of more than 1800 m above sea level and cooler temperatures (19 °C) during the cropping season. The differences in lesion size incited by late blight from various regions may imply that the temperature conditions at the higher altitudes are more conducive for lesion size development. In field studies, however, no significant differences in disease scores were detected among the different regions. Lesion sizes were not quantified in late blight samples from the field.

Our research revealed that that 49–51% of *P. infestans* isolates from Cameroon are metalaxyl resistant, however, the presence of A2 mating type (US 8 genotype) has not been reported. This suggests that the use of metalaxyl-based fungicide compounds may not be suitable strategy for controlling late blight. The metalaxyl-resistant isolates differed in frequencies among the geographic sampling regions and hosts tested. The high proportion of metalaxyl-resistant isolates were observed on potato and tomato, while fewest isolates were from huckleberry may indicate that potato and tomato production may be subjected to chemical use for pest control. The high percentage of resistant isolates in Cameroon may be attributed to the high frequency of fungicide spray. Tomatoes are frequently sprayed more than 10 times per growing season using fungicides such as Ridomil, Ridomil Plus and Dithane M-45 (a.i. mancozeb) (Fontem et al., 2003), while potatoes receive fewer fungicide applications (Fontem and Aighewi, 1993) and farmers rarely spray huckleberries against late blight infections. The frequency of metalaxyl resistance was higher in Bui and Mezam divisions than in Bamboutos division. This is attributed to the highest concentration of commercial potato and tomato farms that are frequently sprayed with fungicides. Matuszak et al. (1994) reported that Mexican populations of metalaxyl resistant *P. infestans* occurred with similar frequencies among potatoes, tomatoes and wild *Solanum* species. Virulence of metalaxyl-resistant strains have also been reported elsewhere (Deahl, et al., 1992).

In the tropical highlands of Africa where potatoes are grown, similar research results have reported the prevalence of metalaxyl sensitivity. Studies conducted from isolates from Kenya and Uganda showed that 73% and 59% of *P. infestans* isolates are sensitive to the above fungicide (Vega-Sanchez et al., 2000). In Uganda, 44% of *P. infestans* isolates were reported to be metalaxyl resistant and 24% metalaxyl intermediate (Mukalazi et al., 2001). High-frequencies (> 51%) of

metalaxyl resistant populations of *P. infestans* have also been reported in potato and tomato fields in South Africa (McLeod et al., 2001). The high frequencies of metalaxyl-resistance have also been reported elsewhere (Cohen and Coffey, 1986; Davidse et al., 1981; Deahl et al., 1992, 1993; Gisi and Cohen, 1996; Vega-Sánchez et al., 2000).

5. Conclusions

We conclude that the use of metalaxyl formulations should be carefully planned in late blight management in Cameroon. The high frequency of metalaxyl-resistant isolates in the northwest province and other regions suggests a possible emergence of metalaxyl-resistant biotypes. The association of metalaxyl-resistant isolates with increased aggressiveness on solanaceous hosts imply that integrated disease management efforts should include reduced fungicide use as well as cultural factors on the cultivated hosts of tomato, potato and garden huckleberry. Similar results have been reported elsewhere. Further studies are necessary to determine pathogen genotypes for molecular characterization of the isolates.

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